RESULTS FROM THE ARCHEOPS CMB EXPERIMENT

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Archeops is a balloon borne CMB experiment.[1] It was built by an international collaboration, led by A. Benoit (CRTBT, INSU/CNRS, Grenoble, France), with several groups from France, Italy, the UK, USA and Russia. Its goals were twofold. On the physics point of view, it was aimed at the measurement of large scale ($\ell \sim 20 - 200$) CMB temperature anisotropies in a region were the pre-WMAP data exhibited a gap. The study of the polarisation of the galactic emission was another important target, since it may constitute an important foreground for the measurement of the CMB polarisation anisotropies precision measurements that are being planned. In parallel with these physics objectives, Archeops was also set up as a test bench for concepts and detectors for the Planck HFI instrument. In this proceeding, I give a brief summary of the CMB power spectrum analysis and of the galactic emission polarisation measurement by Archeops.

1. Instrumental aspects

The key concept of the Archeops experiment's design is its use as a test bench for the Planck mission High Frequency Instrument.[2] We used the same spider-web bolometers, cooled by a similar $^3He/^4He$ dilution cryostat down to 100 mK. In total, 21 bolometers were used in Archeops. They observed in four frequency bands. At 143 and 217 GHz, we had 8 and 6 channels respectively, mainly for CMB studies. At 353 GHz, 3 optics channels were used, but for each of these, light was seperated into two orthogonal polarisation components, observed each by one bolometer. Finaly, one bolometer observed at 545 GHz, were galactic and atmospheric emissions dominate.

Each channel was fed by a doublet of back-to-back horns, cooled down to 10K, a filter (at 1.6K) and a third horn (at 100mK). This cooled optics is very similar to that developped for Planck/HFI. It defines the angular and frequency acceptance of each channel. The detectors were placed at the focal plane of an off-axis gregorian 1.5m telescope. This telescope looked at the sky at an angle of $\sim 50\,\mathrm{deg}$ from the suspension axis. Since the gondola was rotated at two rpm during the flight with respect to that direction, the telescope's observing direction made circular scans on the sky. The Earth rotation during the flight, and to a lesser extend the

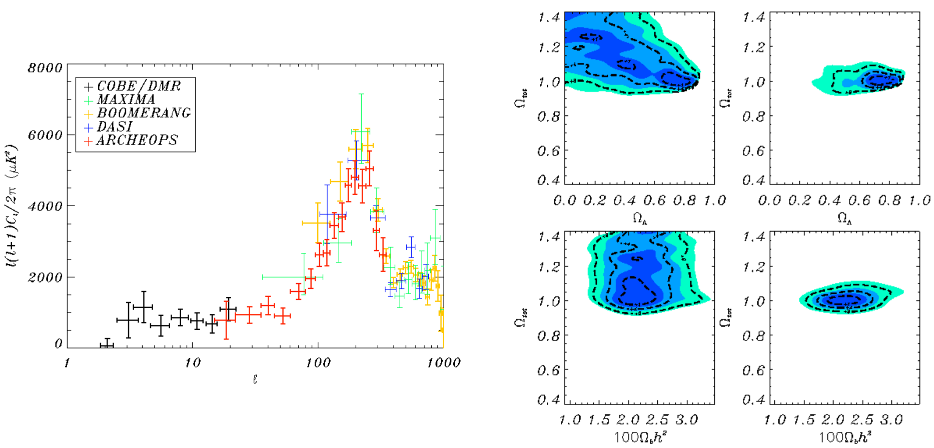

Figure 1. The C_ℓ spectrum from the Archeops data is shown on the left (for more details see Ref 3 and references therein). On the right, we present likelihood contours on the cosmological parameters Ω_{tot} and Ω_Λ extracted from the Archeops spectrum alone (in the right coloumns) and using in addition a prior on H_0 from the HST Extragalactic Distance scale project (right columns).

balloon drift, finally enabled the experiment to cover a large fraction of the sky in our flights (typically, a flight lasted for $\sim$ 12 hours). The typical beam patter was slightly elliptical, with an average r.m.s of 12 arcmin. The pointing accuracy, achieved through a stellar sensor, was of the order of 1 arcmin. Archeops flew between Sicily and Spain in 1999 for a technical test flight, and then during the 2000-2001 and 2001-2002 winters from the Kiruna arctic base, in northern Sweden. The scientific results are essentially extracted from 12h of night data taken during the flight from 07/02/2002.

2. CMB anisotropies

For the CMB analysis[3] we used data from only two channels, one at 143 and one at 217 GHz. A surface of $\sim 15\%$ of the sky was analysed in our CMB analysis, about half of our total coverage, to eliminate the regions closest to the galactic plane. The absolute calibration of the data was done using the cosmic dipole (with an absolute precision of 4 to 8%), and cross-checked using observations of the galaxy and Jupiter (with relative precisions of $\sim 10\%$ each). Temperature maps and C_ℓ spectra were produced using three complementary methods, which produced compatible results (for more details see Ref. 3). Our published C_ℓ CMB spectrum is shown on Fig. 1. From this spectrum, we extracted constraints on the cosmological parameters. For the first time, CMB data, together with a prior on H_0 from the HST was shown to indicate a non zero cosmological constant.[4] We cross-checked our CMB maps with external datasets (from MAXIMA and WMAP, when the latter became available).

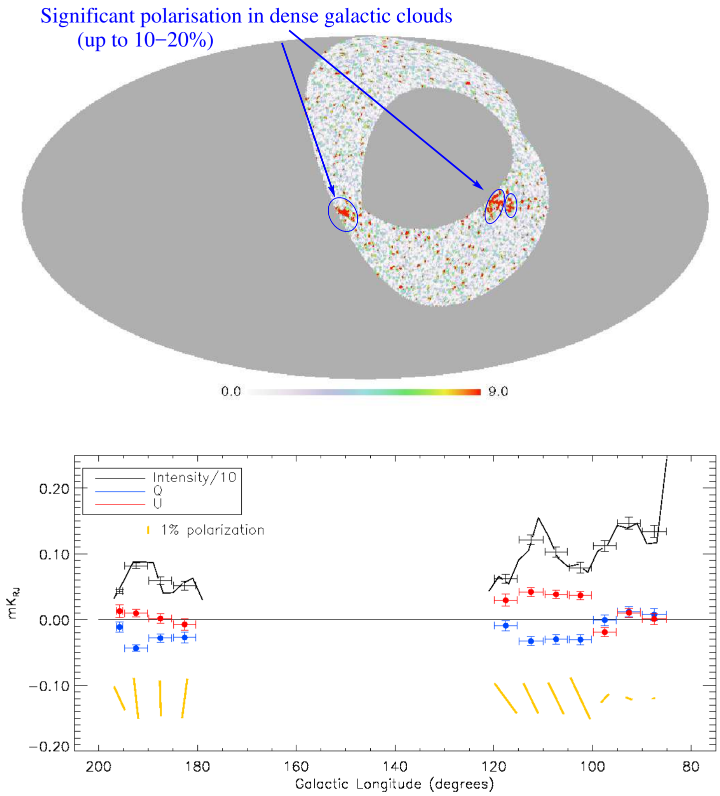

Figure 2. On top we present a significance map of the measured polarization (in standard deviations). We obtained a high significance on small galactic regions. The bottom plot presents the results of a search for diffuse polarized galactic emission, performed using slices perpendicular to the galaxy. The polarization we measure tends to be always perpendicular to the galactic plane, which indicates a coherent orientation of the dust grains by the galactic magnetic field.

3. Galactic emission polarisation

The 353 GHz data was calibrated absolutely using FIRAS data. Bolometric channels were cross-calibrated to a relative precision of $\sim 2\%$ using galactic profiles. This analysis is described in Ref. 5. Its main results are summarized on Fig. 2. From our observations, galactic emissions could constitute an important foreground for Planck/HFI CMB polarisation studies.

References

1. `http://www.archeops.org/`
2. `http://www.planck-hfi.org/`
3. A. Benoit et al., A&A Vol. 399 (2003), L19
4. A. Benoit et al., A&A 399 (2003) L25
5. A. Benoit et al. submitted to A&A (`astro-ph/0306222`)